CLAIMS

1. A grain-oriented electrical steel sheet extremely excellent in film adhesiveness, characterized by: containing, in mass, 2.5 to 4.5% Si, 0.01 to 0.4% Ti, and not more than 0.005% as to each of C, N, S and O, with the balance substantially consisting of Fe and unavoidable impurities; and having films comprising compounds of C with Ti or Ti and one or more of Nb, Ta, V, Hf, Zr, Mo, Cr and W on the surfaces of said steel sheet.

2. A grain-oriented electrical steel sheet extremely excellent in film adhesiveness according to claim 1, characterized by: containing, in mass, 2.5 to 4.5% Si, 0.01 to 0.4% Ti, and not more than 0.005% as to each of C, N, S and O, with the balance substantially consisting of Fe and unavoidable impurities; having films comprising compounds of C with Ti or Ti and one or more of Nb, Ta, V, Hf, Zr, Mo, Cr and W on the surfaces of said steel sheet; and having a magnetic flux density B8 of 1.88 T or more.

3. A grain-oriented electrical steel sheet extremely excellent in film adhesiveness according to claim 1 or 2, characterized in that the average thickness of the compounds, said compounds forming films, of C with Ti or Ti and one or more of Nb, Ta, V, Hf, Zr, Mo, Cr and W, is 0.1 μm or more.

4. A grain-oriented electrical steel sheet extremely excellent in film adhesiveness according to any one of claims 1 to 3, characterized in that the compounds, said compounds forming films, of C with Ti or Ti and one or more of Nb, Ta, V, Hf, Zr, Mo, Cr and W are composed of crystal grains having an average grain diameter of 0.1 μm or more.

5. A grain-oriented electrical steel sheet extremely excellent in film adhesiveness according to any one of claims 1 to 4, characterized in that insulation

coating is applied on the films comprising the compounds of C with Ti or Ti and one or more of Nb, Ta, V, Hf, Zr, Mo, Cr and W.

6. A grain-oriented electrical steel sheet extremely excellent in film adhesiveness according to any one of claims 1 to 5, characterized in that the magnetic domains in said steel sheet are fractionized by introducing at least one of the means of scratch forming, strain imposition, groove forming and foreign matter containment on the surfaces of said steel sheet.

7. A method for producing a grain-oriented electrical steel sheet extremely excellent in film adhesiveness according to any one of claims 1 to 6, characterized in that a steel containing, in mass, 2.5 to 4.5% Si, 0.1 to 0.4% Ti, 0.035 to 0.1% C, and not more than 0.01% as to each of N, S and O, with the balance substantially consisting of Fe and unavoidable impurities, is subjected to the processes of: melting and refining; casting; hot rolling; cold rolling; annealing for 30 min. or longer in the temperature range from 900°C to lower than 1,100°C; and subsequent another annealing for 15 hr. or longer in the temperature range of 1,100°C or higher.

8. A method for producing a grain-oriented electrical steel sheet extremely excellent in film adhesiveness according to any one of claims 1 to 6, characterized in that a steel containing, in mass, 2 to 4.5% Si, 0.1 to 0.4% Ti, and not less than (0.251 x [Ti] + 0.005)% C, with the balance substantially consisting of Fe and unavoidable impurities, is subjected to the processes of: melting and refining; casting; hot rolling; cold rolling; and subsequent high temperature annealing.

9. A method for producing a grain-oriented electrical steel sheet excellent in film adhesiveness according to any one of claims 1 to 6, characterized in that a steel containing, in mass, 2 to 4.5% Si, 0.1 to 0.4% Ti, 0.035 to 0.1% C, and 0.005 to 0.05% in total as

to one or more of Sn, Sb, Pb, Bi, Ge, As and P, with the balance consisting of Fe and unavoidable impurities, is subjected to the processes of: casting; hot rolling; cold rolling to a product thickness; and subsequent high temperature annealing.

10. A method for producing a grain-oriented electrical steel sheet extremely excellent in film adhesiveness according to any one of claims 1 to 6, characterized in that a steel containing, in mass, 2 to 4.5% Si, 0.1 to 0.4% Ti, not less than 0.025% C, and 0.03 to 0.4% Cu, with the balance substantially consisting of Fe and unavoidable impurities, is subjected to the processes of: melting and refining; casting; hot rolling; cold rolling; and subsequent high temperature annealing.

11. A method for producing a grain-oriented electrical steel sheet excellent in film adhesiveness according to any one of claims 1 to 6, characterized in that a steel containing, in mass, 2 to 4.5% Si, 0.1 to 0.4% Ti, and 0.035 to 0.1% C, with the balance consisting of Fe and unavoidable impurities, is subjected to the processes of: casting; hot rolling; cooling to a temperature of 800°C or lower within 10 sec. after the completion of the finish rolling at said hot rolling; then cooling at a cooling rate controlled to 400°C/hr. or lower in the temperature range from 800°C to 200°C; cold rolling to a product thickness; and subsequent high temperature annealing.

12. A method for producing a grain-oriented electrical steel sheet excellent in film adhesiveness according to any one of claims 1 to 6, characterized by: coiling said steel sheet in the temperature range of 800°C or lower within 10 sec. after the completion of the finish rolling at hot rolling; and controlling a cooling rate to 400°C/hr. or lower in the temperature range from the coiling temperature to 200°C by the effect of self-retention of heat caused by said coiling.

13. A method for producing a grain-oriented

electrical steel sheet excellent in film adhesiveness according to any one of claims 1 to 6, characterized in that a steel containing, in mass, 2 to 4.5% Si, 0.1 to 0.4% Ti, and 0.035 to 0.1% C, with the balance consisting of Fe and unavoidable impurities, is subjected to the processes of: casting; hot rolling; subsequent hot band annealing in the temperature range from 1,100°C to 900°C; cold rolling to a product thickness; and subsequent high temperature annealing.

14. A method for producing a grain-oriented electrical steel sheet excellent in film adhesiveness according to any one of claims 1 to 6, characterized in that a steel containing, in mass, 2 to 4.5% Si, 0.1 to 0.4% Ti, and 0.035 to 0.1% C, with the balance consisting of Fe and unavoidable impurities, is subjected to the processes of: casting; hot rolling; hot band annealing at a cooling rate of 50°C/sec. or lower; cold rolling to a product thickness; and subsequent high temperature annealing.

15. A method for producing a grain-oriented electrical steel sheet extremely excellent in film adhesiveness according to any one of claims 1 to 6, characterized in that a steel containing, in mass, 2.5 to 4.5% Si, 0.1 to 0.4% Ti, and 0.03 to 0.10% C, with the balance substantially consisting of Fe and unavoidable impurities, is subjected to the processes of: melting and refining; casting; hot rolling; once or more of subsequent heat treatments applied during the intervals between cold rolling passes in the event of cold rolling, said steel sheet being retained for 1 min. or longer in the temperature range from 100°C to 500°C at each of said heat treatments; and subsequent high temperature annealing.

16. A method for producing a grain-oriented electrical steel sheet extremely excellent in film adhesiveness according to any one of claims 1 to 6, characterized in that a steel containing, in mass, 2.5 to

4.5% Si, 0.1 to 0.4% Ti, and 0.03 to 0.10% C, with the balance substantially consisting of Fe and unavoidable impurities, is subjected to the processes of: melting and refining; casting; hot rolling; subsequent cold rolling while the temperature of said steel sheet is maintained in the temperature range from 100°C to 500°C after the end of the first cold rolling pass; and subsequent high temperature annealing.

17. A method for producing a grain-oriented electrical steel sheet extremely excellent in film adhesiveness according to any one of claims 1 to 6, characterized in that a steel containing, in mass, 2 to 4.5% Si, 0.1 to 0.4% Ti, and not less than 0.025% C, with the balance substantially consisting of Fe and unavoidable impurities, is subjected to the processes of: melting and refining; casting; hot rolling; cold rolling; subsequent heating at a heating rate of 1°C/sec. or higher at least in the temperature range from 400°C to 700°C; annealing in the temperature range from 700°C to 1,150°C; and subsequent high temperature annealing.

18. A method for producing a grain-oriented electrical steel sheet extremely excellent in film adhesiveness according to any one of claims 1 to 6, characterized in that a steel containing, in mass, 2 to 4.5% Si, 0.1 to 0.4% Ti, and not less than 0.025% C, with the balance substantially consisting of Fe and unavoidable impurities, is subjected to the processes of: melting and refining; casting; hot rolling; cold rolling; subsequent heating at a heating rate of 1°C/sec. or higher at least in the temperature range from 400°C to 800°C; annealing in the temperature range from 800°C to 1,050°C; and subsequent high temperature annealing.

19. A method for producing a grain-oriented electrical steel sheet excellent in film adhesiveness according to any one of claims 1 to 6, characterized in that a steel containing, in mass, 2 to 4.5% Si, 0.1 to 0.4% Ti, and 0.035 to 0.1% C, with the balance consisting

of Fe and unavoidable impurities, is subjected to the processes of: casting; hot rolling; cold rolling to a product thickness; subsequent high temperature annealing, wherein said steel sheet is heated continuously or stepwise with isothermal retention interposed in between in the heating temperature range from 700°C to 1,000°C, and the annealing time is controlled so that, when an arbitrary temperature in said heating temperature range is defined as T°C, a retention time t in the temperature range from T°C to T + 100°C may satisfy the expression $t \geqq 5^x$, or $t \geqq 0.5$ if the value of 5^x is 0.5 or less, where x is defined as $x = 9 - T/100$.

20. A method for producing a grain-oriented electrical steel sheet excellent in film adhesiveness according to any one of claims 1 to 6, characterized by, in the method according to claim 19: coiling said steel strip in the temperature range of 500°C or lower within 10 sec. after the completion of the hot rolling; and controlling a cooling rate to 200°C/hr. or lower up to a temperature of 200°C by the effect of self-retention of heat caused by said coiling.

21. A method for producing a grain-oriented electrical steel sheet excellent in film adhesiveness according to any one of claims 1 to 6, characterized by, in the method according to any one of claims 7 to 20, applying purifying annealing for 15 hr. or longer in the temperature range of 1,100°C or higher.

22. A method for producing a grain-oriented electrical steel sheet extremely excellent in film adhesiveness according to claim 5, characterized in that a steel containing, in mass, 2.5 to 4.5% Si, 0.1 to 0.4% Ti, 0.035 to 0.1% C, and not more than 0.01% as to each of N, S and O, with the balance substantially consisting of Fe and unavoidable impurities, is subjected to the processes of: melting and refining; casting; hot rolling; cold rolling; annealing for 30 min. or longer in the temperature range from 900°C to lower than 1,100°C;

subsequent another annealing in the temperature range of 1,100°C or higher; subsequent flattening annealing in the temperature range of 700°C or higher; and further applying insulation coating and baking.

23. A grain-oriented electrical steel sheet extremely excellent in film adhesiveness according to any one of claims 1 to 6, characterized in that the magnetic domains in said steel sheet are fractionized by introducing at least one of the means of scratch forming, strain imposition, groove forming and foreign matter containment on the surfaces of said steel sheet.